Use of Magnetic Flux Techniques to Detect Wheel Tread Damage

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Overview

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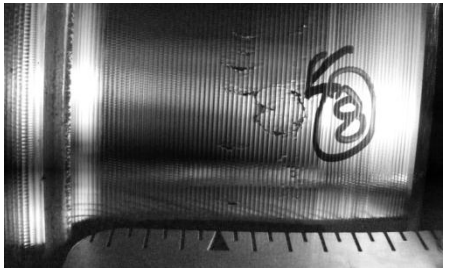
- Background
- Wheel tread damage
- SCM development
- Theory of SCM
- Wheel handheld unit
- Damage types
- Summary
- Acknowledgements

Background

- Wheelset account for a large proportion of a fleets whole-life costs
- Wheelsets are routinely maintained to ensure safe operation and prolong life
- This includes measurements to inspect:
  - Roundness
  - Profile shape
  - Rim thickness
  - Visual inspection of surface damage

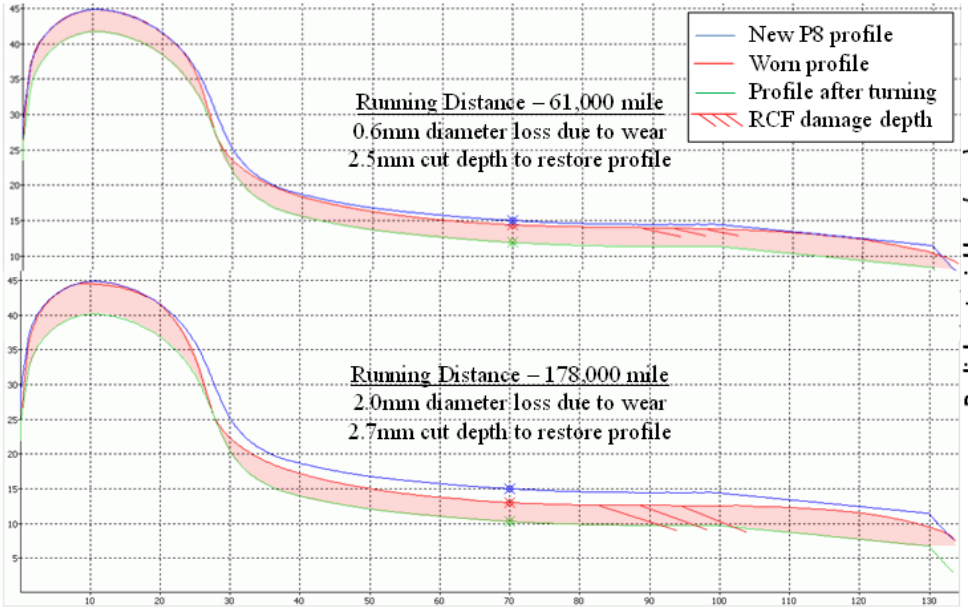
Wheel Tread Damage

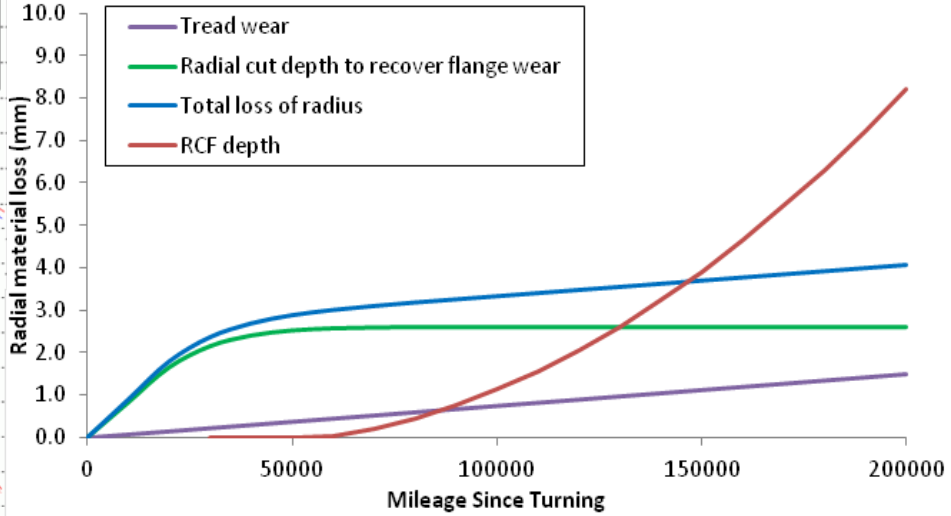
- Surface damage is difficult to classify through visual inspections
  - Not possible to establish depth of damage
- Wheelsets are re-profiling to remove any identified damage
- Crucial balance exists:
  - Removing enough material to eliminate the damage
  - Minimising cut depth to preserve the rim thickness
- Taking multiple smaller cuts increases time at wheel lathe



Cut Depths

- Example radial material loss during turning



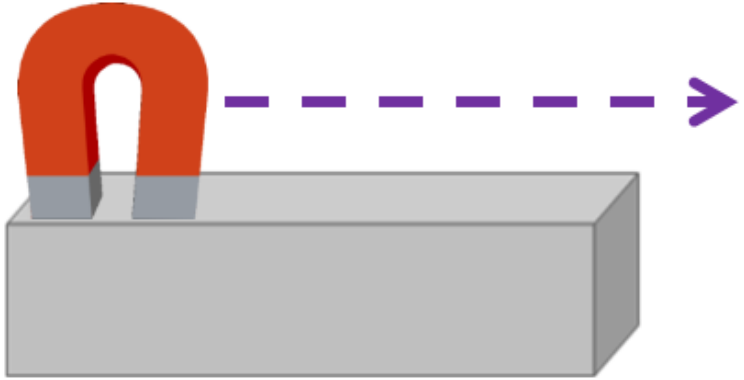


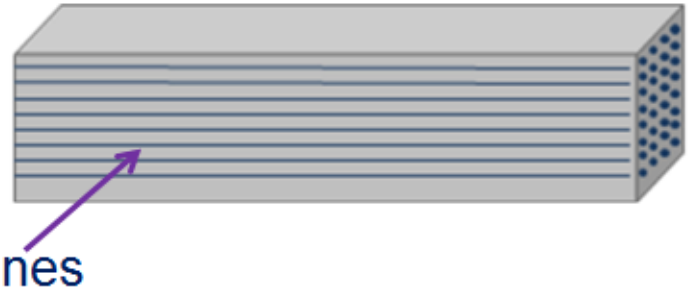
SCM Development

- MRX's Surface Crack Measurement (SCM) technology has been in use on rails for 8+ years
- Technology has been adapted to measure surface damage on wheels using a hand held device
- Funding awarded through the RSSB/Future Railway '*Rail Operator Challenge Competition*' to validate and further develop the product in collaboration with:
  - Bombardier Transportation
  - Institute of Rail Research, University of Huddersfield
  - Arriva Trains

Theory of SCM – 1

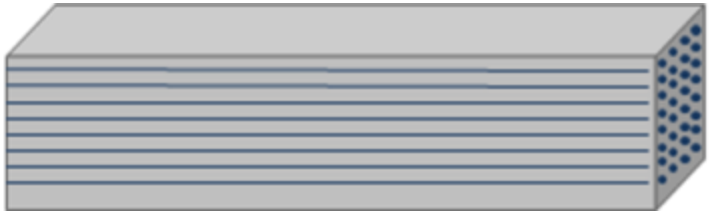
- Magnetic Particle Inspection (MPI) and SCM are similar
- They involve magnetizing the specimen surface
- This introduces lines of magnetic flux into the specimen

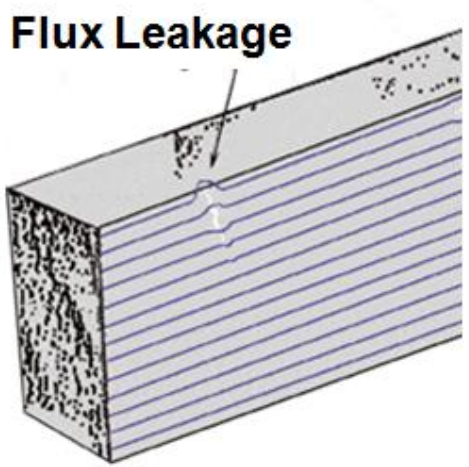




Theory of SCM – 2

- In a defect free specimen, these lines travel undisturbed through the specimen
- If a defect is present, the flux cannot travel as easily through it
- This causes some flux to leak at the position of the defect





Wheel Handheld Unit – 1

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- Wheel SCM uses 16 magnetic field sensors to measure and record the leaking flux
- Reports the depth of the deepest artifact in the scan
  - Amount of material to remove from the wheel to eliminate the damage

Wheel Handheld Unit – 2

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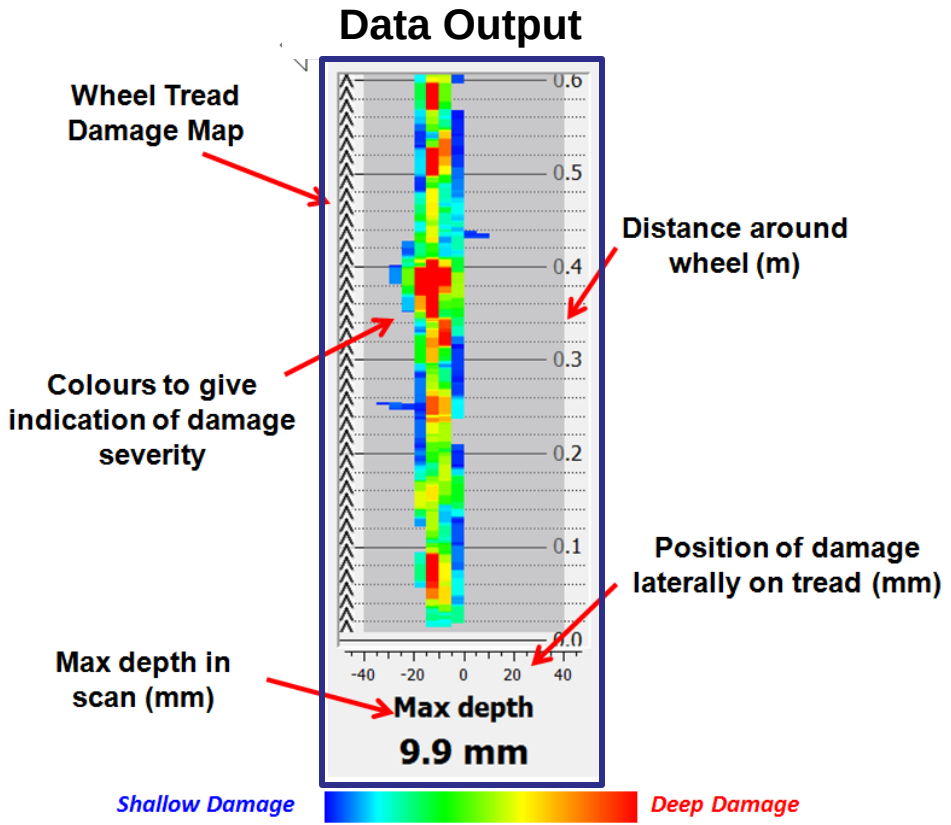
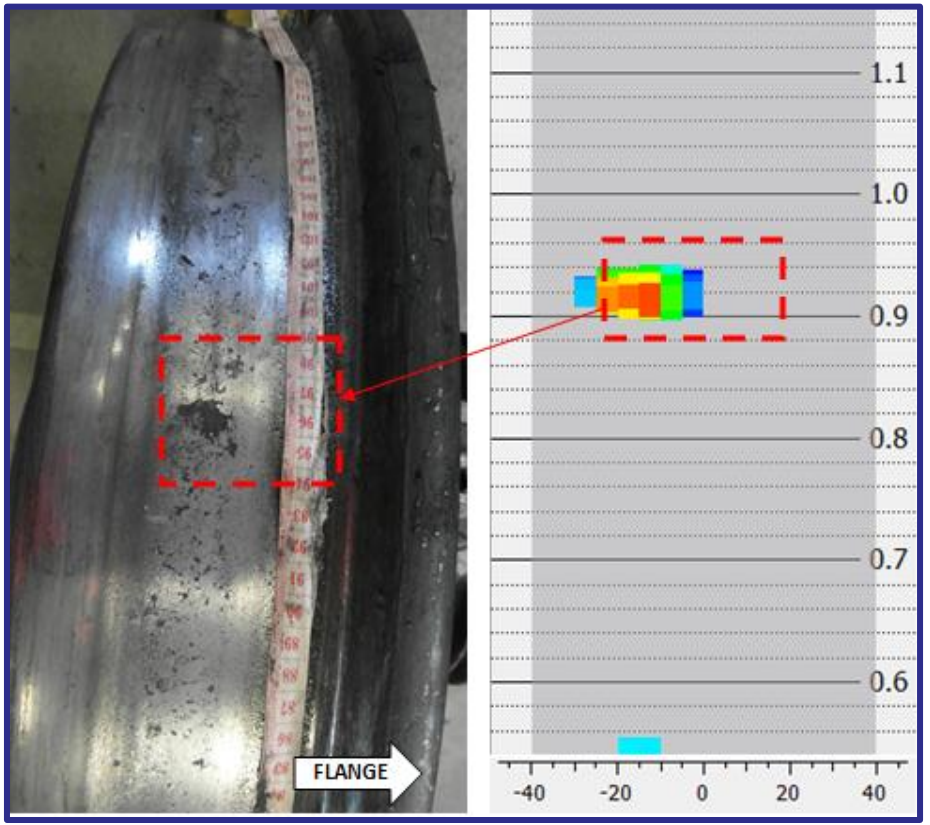
- Handheld unit specification:
  - 1mm = Lower Detection Limit (shallowest artifact)
  - 10mm = Upper Detection Limit (deepest artifact)
  - +/-0.5mm = System Accuracy



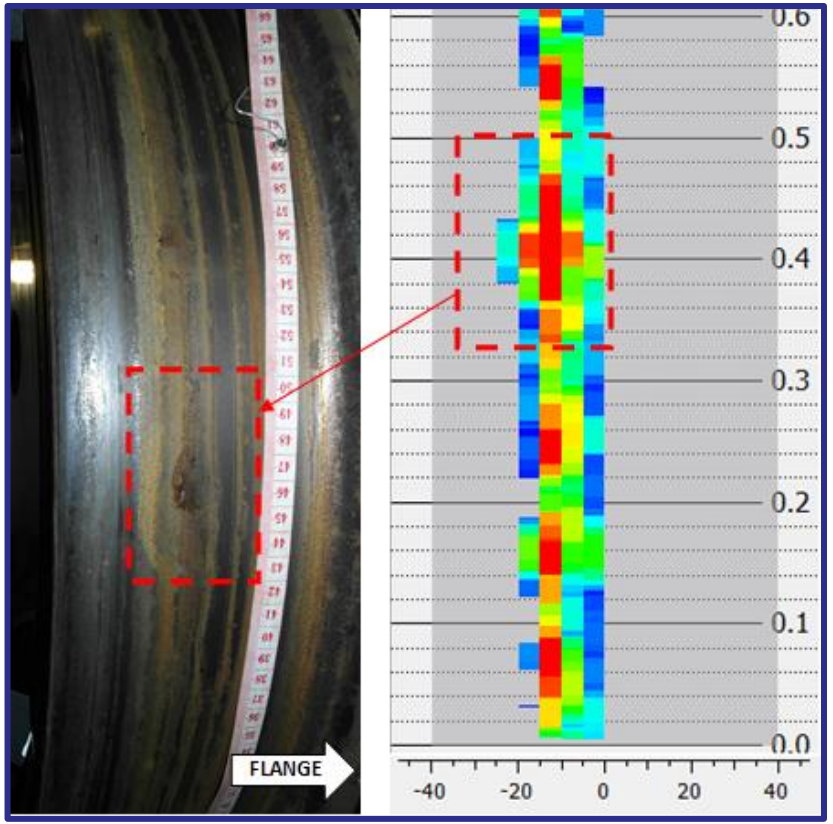
Damage Types – 1

- Surface breaking and near-surface damage
  - Cracking and cavities



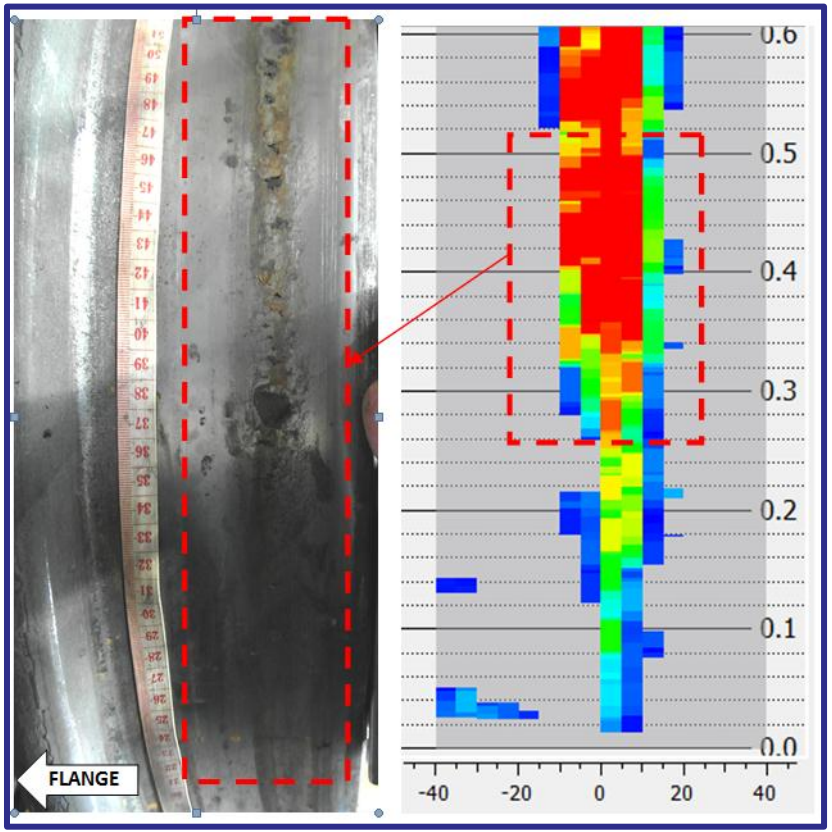
Damage Types – 2

- Surface breaking and near-surface damage
  - Rolling contact fatigue (RCF) cracking



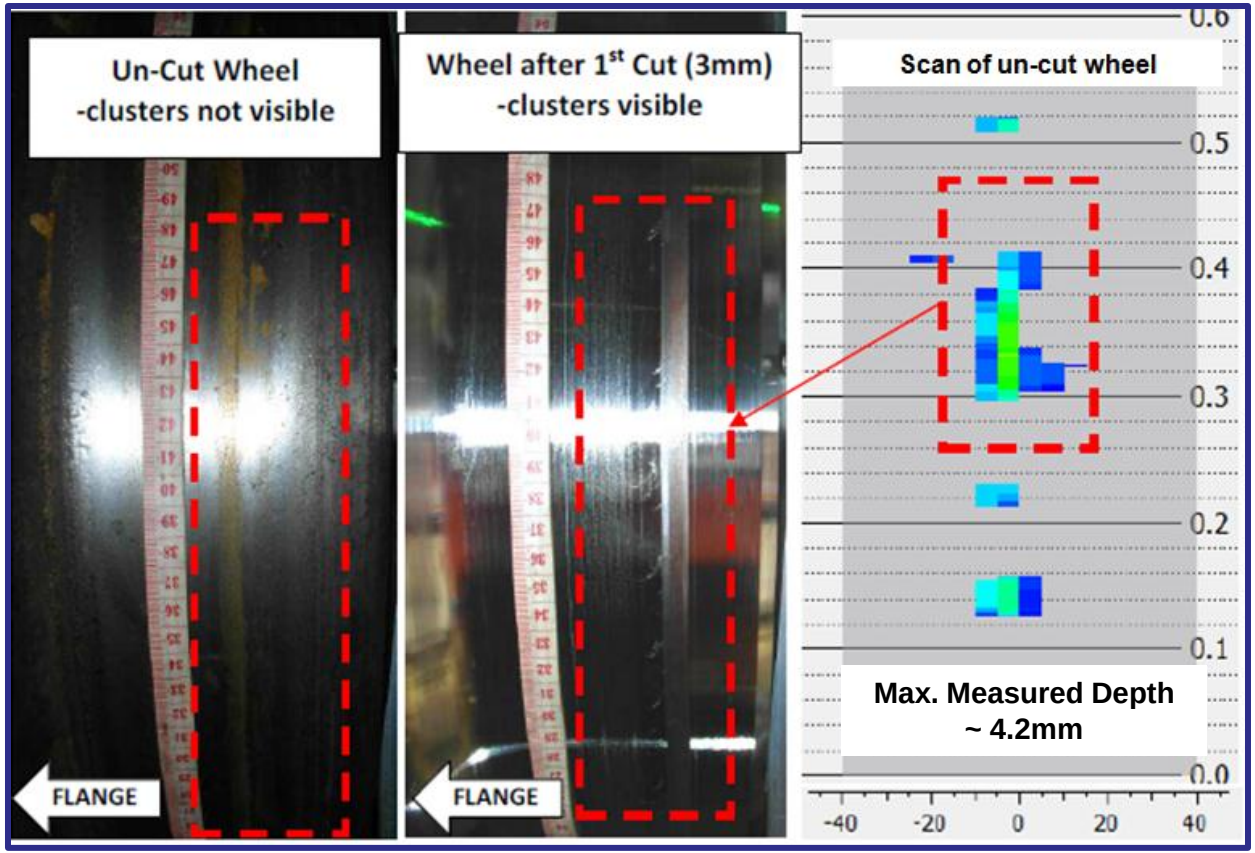
Damage Types – 3

- Surface breaking and near-surface damage
  - Rolling contact fatigue (RCF) cracking
  - Thermal cracking and cavities



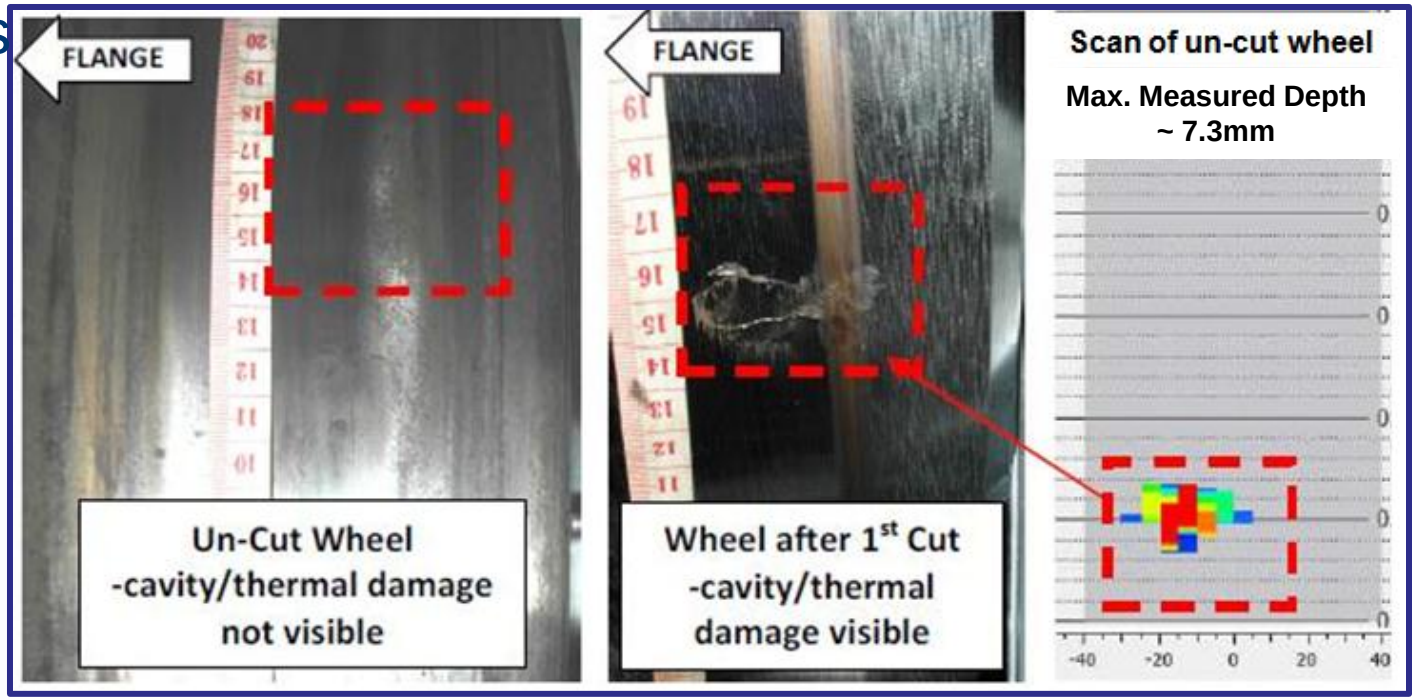
Non-visible Damage – 1

- HHU reveals damage not visible on uncut wheel



Non-visible Damage – 2

- HHU reveals damage not visible on uncut wheel



Damage Free Wheel

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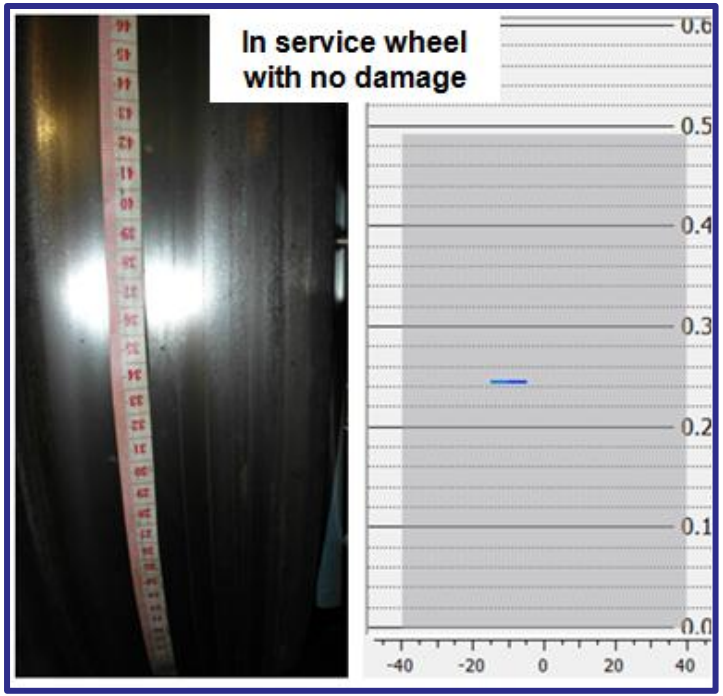
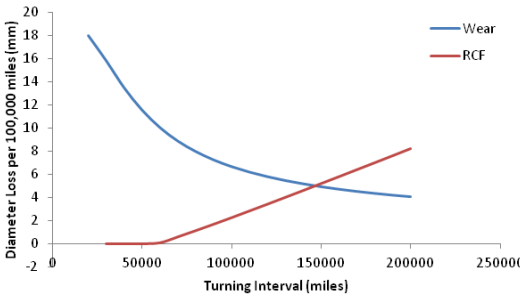
- Confirms when wheel is damage free



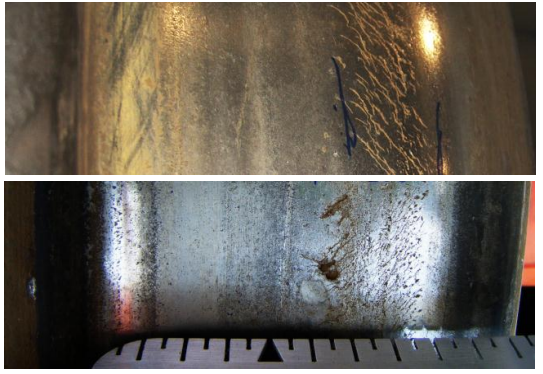
Summary

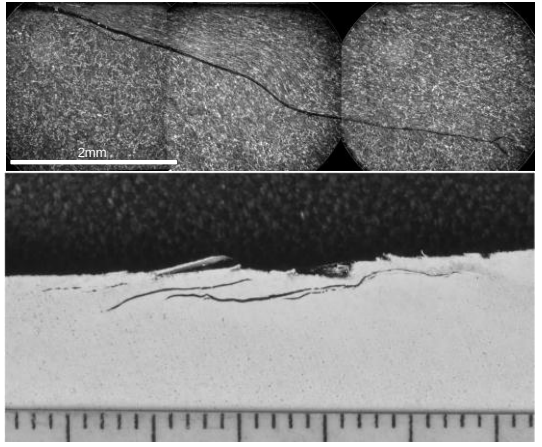
- SCM technology has been adapted to evaluate surface and sub-surface defects in wheels
- Potential uses include:
  - ***Replacing visual inspection during routine maintenance exams***
    - Repeatable, not reliant on judgement
    - Reveals damage that is not obvious/visible on uncut tread
  - ***Optimisation of cut depths at wheel lathe***
    - Reduce risk of overcutting and also saves time removing defects
  - ***Trending to understand RCF development and growth rates***
    - Improved planning of maintenance
    - Highlight problem wheels/vehicles
  - ***Supporting specific case studies***
    - New profiles, steels etc. (monitor performance)



Next Steps

- Further wheel lathe trials to confirm damage depth readings and access constraints etc.
- Further developments of prototype HHU
- Assessment of scrap wheels:
  - Samples to be examined optically to determine deformation depth, crack length and crack depth
  - Micro-hardness testing
  - Correlation HHU readings with measured damage
- Business case detailing the benefits of the data for trending and maintenance planning





Acknowledgments

- The results and findings presented were developed as part of the RSSB/Future Railway managed '*Rail Operator Challenge Competition*'

- For further information visit us at the blue-sky village exhibition or contact:
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  - sek@mrxtech.co.uk